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The effectiveness of kinesiotaping in treatment of the soft tissue injuries in adolescent football players

Skuteczność kinesiotapingu w leczeniu urazów tkanek miękkich u młodych sportowców

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S u m m a r y

Aim. To evaluate the effectiveness of kinesiotaping in the treatment of soft tissue injuries of adolescent football players.

Material and methods. 30 players with soft tissue injuries of the lower limb were randomly assigned to one of the two groups: a study (15) or a control group (15). The subjects ranged from 12 to 15 years of age. The control group received traditional physiotherapeutic treatment for their injuries. The study group received the traditional treatment plus additional kinesiotaping treatment. The effectiveness of kinesiotaping was evaluated based on three variables: range of joint motion, level of pain during the muscle resistance tests, and proprioception during the one-leg standing test. Data were measured three times: on the first, third, and seventh day following the incident (1, 3, 7).

Results. The results show a statistically significant decrease in pain intensity in both groups on each day when data were recorded. Concerning proprioception, the time of standing on the contused limb was increasing in both groups. However, the results do not show significant differences between the groups on days when measurements were taken.

The results of the range of motion deficit show a statistically significant decrease relative to the amount of time since injury. On the seventh day, a lower deficit in the study group was noted in comparison to the control group. However, players in both groups did not reach full range of motion.

Conclusions. 1) Kinesiotaping is an effective method in pain reduction in soft tissue injuries. It can assist practitioners as a complementary method in rehabilitation treatment of soft tissue injuries in adolescent athletes. 2) Faster post-injury pain reduction implies earlier return to full athletic activity. 3) The applied kinesiotaping techniques (muscle and lymphatic correction) do not effect improvement of proprioception in injured athletes.

Key words: kinesiopating, soft tossue injuries, physiothreapy, sport, football

S t r e s z c z e n i e

Cel pracy. Celem pracy była ocena skuteczności kinesiotapingu w leczeniu urazów tkanek miękkich u młodych zawodników piłki nożnej.

Materiał i metody. Zbadano 30 sportowców w wieku 12-15 lat, którzy doznali urazów mięśniowych kończyn dolnych. Zawodnicy zostali podzieleni na dwie 15-osobowe grupy: badawczą i kontrolną. Po urazie wszyscy zostali poddani fizjoterapii ukierunkowanej na terapię tkanek miękkich, a zawodnikom z grupy badawczej dodatkowo naklejono taśmę kinesiotape. U badanych w obrębie kontuzjowanej kończyny oceniono: zakres ruchomości stawów, dolegliwości bólowe podczas testów oporowych mięśni oraz czucie głębokie podczas testu stania na jednej nodze. Wszyscy zawodnicy badani byli trzykrotnie: w dniu urazu, 3. i 7. dnia od urazu.

Wyniki. Odnotowano statystycznie istotne zmniejszenie dolegliwości bólowych w grupie kontrolnej i badawczej w kolejnych dniach badania. W zakresie propriocepcji w obu grupach czas stania na kontuzjowanej kończynie wydłużał się, jednak nie odnotowano istotnych statystycznie różnic w poszczególnych dniach pomiędzy nimi.

Wartości deficytu zakresu ruchu w obu grupach istotnie statystycznie zmniejszały się wraz z upływem czasu. Siódmego dnia w grupie badawczej deficyt ten był mniejszy niż w grupie kontrolnej, jednak zawodnicy z obu grup nie uzyskali jeszcze pełnego zakresu ruchu.

Wnioski. 1) Kinesiotaping jest skuteczną metodą w redukcji bólu podczas leczenia urazów tkanek miękkich i może być z powodzeniem stosowany jako uzupełnienie procesu usprawniania po przebytym urazie tkanek miękkich wśród młodych

sportowców. 2) Szybsza redukcja bólu pourazowego wpływa na szybszy powrót zawodnika do pełnej aktywności sportowej. 3) Zastosowane aplikacje: mięśniowa i limfatyczna plastra kinesiotape nie wpływają na przyspieszenie w uzyskaniu poprawy propriocepcji u kontuzjowanych zawodników.

Słowa kluczowe: kinesiotaping, urazy tkanek miękkich, fizjoterapia, sport, piłka nożna

INTRODUCTION

In the field of physiotherapy, kinesiotaping has been recognized as a method for facilitating rehabilitation treatment and modifying certain physiological processes. It has been used in orthopedics, rehabilitation and sports medicine (1).

The kinesiotaping technique was invented in the 1970's by dr. Kenzo Kase – a Japanese chiropractor. The objective of his method is to capitalize on the natural self-healing processes of an organism and to sustain this therapeutic effect.

The tape used in kinesiotaping is made from high-quality cotton with a layer of acrylic (100%). It does not contain any medicinal ingredients or latex. The tape's thickness, specific gravity, and elasticity are close to the parameters of human skin. It is water and airproof enabling patients to carry out activities such as washing or swimming. The tape extends in one direction, which permits the correction of the cutaneo-fascial system (2). A particular advantage of the tape is its' durability. It has the capacity to remain fastened for 5 to 7 days, which means a 24-hour therapy.

Kinesiotaping is effective across a broad spectrum of conditions. Depending on the tape application, it produces the following results (2):

- Maintenance of a full range of motion
- Normalization of muscular pressure as well as activation of damaged muscles
- Decrease in pain and in pathological skin sensitivities
- Disappearance of blockages and lymphatic swellings
- Correction of inappropriate joint positions
- Proper position of fascia and skin
- Improved microcirculation
- Improved proprioception

In terms of tape application, there are seven basic techniques. These are so-called corrective methods (3, 4):

1. Muscle Correction. This is the most frequently used technique. The tape is applied along the muscle tissue, without stretching the tape, but with its maximal extension.
2. Mechanical Correction. This technique is used to obtain natural positioning. It stimulates mechanoreceptors, which provide information about the correct positioning of a joint, muscle, or fascia.
3. Fascial Correction. This method is applied to activate or to shift fascia in the appropriate direction. The tension of the tape should remain within 25-50%. The desired tension can be achieved by using two techniques:
   a) Manual shifting of fascia, followed by the tape application in order to maintain its new position.
   b) Stimulation of tension by oscillating the tape and causing the movement of fascia.
4. Space Correction. This technique is used to create space directly above the source of pain, inflammation, or swelling. The space facilitates the reduction of pressure by lifting up the skin.
5. Tendon Correction. It is used to increase stimulation in the vicinity of tendon or ligament. This method causes increased stimulation of mechanoreceptors. The tape tension should be in the range of 50 to 75%.
6. Lymphatic Correction. This technique is applied to create space with a decreased pressure under the tape. The tape acts as a channel directing secretions to the nearest lymphatic canal. The tape tension should stay at 0-15% and the stripes are applied in the shape of a fan with its base placed under the lymphatic gland.
7. Functional Correction. It is used to obtain sensory stimulation in order to support or to limit a given movement. The tape is applied during the active motion using the tension of 50-100%. In addition, this method supports stimulation of mechanoreceptors.

We evaluated the effectiveness of kinesiotaping while treating a group of adolescent athletes who had been diagnosed with soft tissue injuries after playing football. Football is a sport characterized by a high risk of contusion. Therefore, the main role of a physiotherapist is to enable a quick return of a player to the field.

Currently, football-related injuries account for approximately 50-60% of all sports injuries, in which 3% require hospitalization. The frequency of injuries is undeniably related to the specific nature of the game, which involves bodily contact between the players (5). Epidemiological data show that the majority of contusions display the characteristics of injuries, and 67% occur during a competition. However, overloading symptoms appear in only 9-34% of players (5, 6). In the etiology of the injuries, the internal and external factors should be taken into account. The internal factors include fatigue caused by insufficient break periods, a too quick return to training with insufficiently healed injuries, lack of appropriate warm-ups, or inadequately trained athletes. The external factors are primarily the lack of adherence to the rules of the game on the part of opposing team players, poor physical state of a field, or adverse weather conditions (7).

The type of injuries varies depending on the age of an athlete. In football, among young players, the most frequent injuries are bruising (32,9-47%) and sprain. It is not unusual to see players with wounds or scrapes (6-39%). Among adult players, the most frequent injuries are ankle sprain (28-35%), muscle strain (10-47%) and bruising (8,3-21,3%) (5, 6). In football-related injuries 75 to 93% affect lower limbs, where knee, ankle and foot joints are most frequently afflicted. Head, neck, and spine injuries account for the next most common type, followed by injuries of upper limbs, which affect mainly goal keepers and generally represent damage to shoulder, elbow and fingers (5, 6, 8). Due to the mode of introductory training, most injuries occur during this stage with the occurrence of 89% of all injuries (matches – 67%, training – 22%), and 11% of players experiencing a contusion during this period (7).

AIM

The general aim of the study was an evaluation of the effectiveness of kinesiotaping in the treatment of soft tissue injuries and the measurement of time required for full recovery of injured athletes. Additionally the assessment of the tape's impact on pain reduction, the improvement of proprioception and the increase of range of motion of the injured joint in comparison to a control group were conducted.

MATERIAL AND METHODS

In prospective studies, 30 athletes with lower limb muscle injuries were selected. The players were in the range of 12 to 15 years of age, with an average of 13,5 ± 0,04 years. All subjects were members of the junior teams of a football club named KKS Lech located in Poznań, Poland. The players were divided into two 15-person groups: study group (average age of 13,47 ± 1,06 years) and control group (average age 13,53 ± 1,06 years). Following an injury, all participants underwent physiotherapy (tab. 1). The kinesiotape was also applied to the study group. The control group did not receive this additional treatment. Tape applications varied depending on the nature of an injury.

Individuals were randomly assigned to the study or control groups.

All diagnoses by physiotherapist were confirmed by the club's orthopedic surgeon and through ultrasound examinations.

During the study the following variables were assessed:

- Range of motion of individual joints of the lower limb.
- Pain experienced during the resistance tests in selected lower limb muscles.
- Proprioception of an injured limb during the one-leg standing test.

The K-Active Tape 50 mm. x 5 m. was used.

During the study, all athletes were tested three times: on the day of injury, on the third day following injury, and on the seventh day after the incident.

Table 1. Physiotherapeutic methods applied during therapy of an injured body part.

Day	Strain	Bruising
1.	RICE (rest, ice, compression, elevation)	RICE
2.	RICE	RICE
3.	– various forms of message; – postisometric relaxation; – stretching; – static proprioception exercises.	– message of a limb; – cold treatment
4.	– as in 3rd day	– as in 3rd day + – postisometric relaxation – stretching – static proprioception exercises.
5.	– as in 3rd and 4th day + – strengthen exercises with TheraBand	– as in 4th day + – jogging
6.	– as in 5th day	– strengthen exercises with TheraBand
7.	– jogging	– as in 6th day

Resistance tests were used to assess a contractile structures. The tests involve maximal isometric contraction of a given muscle. Pain or decreased muscle strength during this procedure indicates muscular dysfunction (9).

In the study, the resistance tests were conducted on the following lower limb muscles (10):

1. quadriceps femoris muscles,
2. hamstrings muscles,
3. abductor muscles,
4. adductor muscles,
5. tibialis anterior muscle,
6. gastrocnemius muscle,
7. soleus muscle.

During the resistance tests, the athletes self-assessed the degree of pain using the Numerical Rating Scale (NRS). The scale consists of 11 degrees of pain perception, where 0 indicates no pain and 10 an intolerable degree of pain (11). In terms of pain evaluation, only the data related to the degree of pain in the injured muscles were analyzed.

Proprioception and static balance were measured during the one-leg standing test. The supporting leg must be straight. Both legs are used alternatively. The time of a balanced position of a subject was measured with eyes open and closed. Each subject was allowed three attempts, with a maximum of 30 seconds for each attempt. The best timing (longest) for each player was used in the analysis.

The measurement of the range of motion was performed using goniometer with the following parameters being evaluated (10):

1. Hip flexion.
2. Hip abduction and adductor muscles contracture. The examination was performed in two positions: with knee flexed and extended.

3. Hip adduction and abductor muscles contracture.
4. Knee flexion and quadriceps muscle contracture.
5. Popliteal angle and hamstrings muscles contracture.
6. Silverskiöld test to evaluate gastrocnemius and soleus muscles contracture.
7. Plantar flexion of the foot and tibialis anterior muscle contracture.

Only data related to the range of motion of a lower-limb joint affected by injury were analyzed. Deficiencies of the range of motion were assessed using a percentage value and expressing the degree of divergence from the norm (100%). Values initially measured in degrees (°) were converted to percentages (%), because individual ranges of motion differ depending on the type of an injured muscle.

STATISTICAL ANALYSIS

The homogeneity of variances between the two data sets was analyzed using the F-Snedecor test. In cases of divergence of variances between the trials, the Wilcoxon signed rank test for paired group or the Wilcoxon rank sum test for unpaired group (U-Mann-Whitney) was used. In all other cases, the Student's t-Test was applied for both groups. The only exception was the evaluation of pain, where the NRS scale was used. To analyze pain-related data, the Wilcoxon test was used for paired and unpaired groups.

Values, with $p < 0.05$ were considered as statistically significant. All statistical analyses were performed using the statistical application R – version 2.10.1.

RESULTS

The purpose of analysis was the assessment of effectiveness of kinesiotaping on pain reduction, improvement of proprioception, and increase of range of motion in lower limb joints. While analyzing data, the study's primary focus was on values obtained after a few-day period (days 3 and 7), instead of values recorded immediately after the tape application. See table 2 for all results. The statistical analysis within each group as well as comparative data between the study and the control groups are captured in table 3. Due to the heterogeneity of injuries in both groups, the results pertaining to the range of motion are not given.

The analysis reveals statistically significant pain reduction in both groups as shown by downshifting values relative to the time following the injury. While all athletes in the study group were completely relieved of pain on day 7, some participants of control group still experienced a minimal degree of pain. The data confirms statistically significant difference in pain perception on day 7. This may suggest that the application of kinesiotape facilitates quicker decrease in pain perception.

In terms of proprioception, only data related to the injured limb were analyzed, as all participants achieved the maximum time during the one-leg standing test when using uninjured leg for support. Players in both groups were able to achieve progressively longer one-leg standing periods over the seven-day span. On day 7, the time recorded for each group shows the maximum timing in 13 cases of the control group (86,66%) and 15 cases in the study group (100%). However,

Table 2. Results. Basic characteristic of groups (days 1, 3, 7).

Outcomes	Group	Day	Mean	SD	Median	Q1	Q3	Range (MIN-MAX)
Pain	Study	1	4.20	1.42	4.00	3.00	5.00	2.00-7.00
		3	1.60	1.24	2.00	0.50	3.00	0.00-3.00
		7	0.00	0.00	0.00	0.00	0.00	0.00-0.00
	Control	1	4.80	2.14	5.00	3.00	6.50	2.00-8.00
		3	2.27	1.83	2.00	1.00	4.00	0.00-5.00
		7	0.40	0.63	0.00	0.00	1.00	0.00-2.00
Proprioception	Study	1	24.33	7.04	25.00	20.00	30.00	10.00-30.00
		3	28.87	2.80	30.00	30.00	30.00	20.00-30.00
		7	30.00	0.00	30.00	30.00	30.00	30.00-30.00
	Control	1	21.73	5.62	20.00	16.50	25.00	15.00-30.00
		3	27.33	3.56	30.00	25.50	30.00	20.00-30.00
		7	29.73	0.80	30.00	30.00	30.00	27.00-30.00
Range of motion	Study	1	28.52	36.60	0.00	0.00	55.55	0.00-100.00
		3	21.48	32.71	0.00	0.00	31.95	0.00-100.00
		7	6.85	15.25	0.00	0.00	5.55	0.00-55.56
	Control	1	38.81	33.12	44.44	5.77	52.78	0.00-100.00
		3	28.74	25.65	25.00	1.92	44.44	0.00-75.00
		7	12.07	17.89	0.00	0.00	21.11	0.00-50.00

SD – standard deviation, Q1 – quantile 1, Q3 – quantile 3, MIN – minimum, MAX – maximum.

Table 3. Comparison within each group (study/control) and between study and control group using the Wilcoxon Signed Rank or the Student's T-test for paired group, and the Wilcoxon Rank Sum (Mann-Whitney) or the Student's T-test for unpaired group with significance level p = 0.05.

Comparison	Group	n	pain*	proprioception*	ROM*
1:3 day	Study	15	**0.001**	**0.01177**	**0.0238**
	Control	15	**0.0005967**	**< 0.000001**	**0.001975**
3:7 day	Study	15	**0.003385**	0.1814	**0.03552**
	Control	15	**0.002346**	**0.0213**	**0.0004702**
1:7 day	Study	15	**0.0006756**	**0.01321**	**0.02154**
	Control	15	**0.0006928**	**0.00243**	**0.002328**
1:1 day	study vs control	30	0.4878	0.2736	–
3:3 day	study vs control	30	0.3196	0.2009	–
7:7 day	study vs control	30	0.01779	0.1644	–

*p < 0.05 statistical significant.

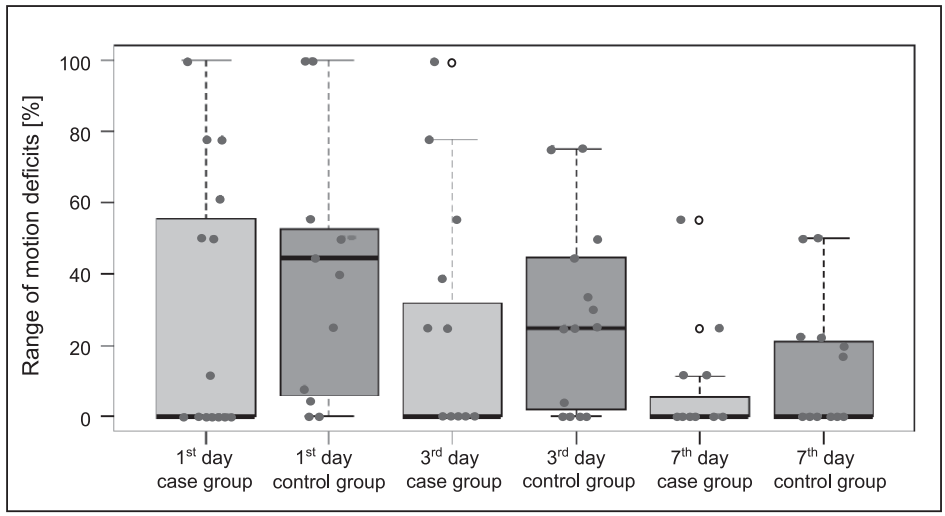

Fig. 1. Percentage values of the deficit in range of motion recorded on days 1, 3, 7. The dots indicate values for individual athletes.

there is not statistically significant difference between the groups on individual days when data were collected (days 1, 3, 7).

The deficit in range of motion in both groups shows statistically significant reduction relative to the time following the injury. On the seventh day, the deficit in the study group was smaller in comparison to the control group. However, players in both groups did not achieve full range of motion.

Due to the divergence of injuries in each group, their percentage values were not subject to statistical analysis. Figure 1 exhibits the range of data pertaining to the deficit in range of motion in each group as well as in each participant.

DISCUSSION

The study confirms the effectiveness of kinesiotaping in the reduction of post-injury pain in contused players. In both groups, the level of pain progressively diminished following the day of injury. However, on the seventh day, the difference between the groups was statistically significant (p=0.01779). In the study group the pain completely disappeared, while it was still reported in the control group. The longer period of pain reduction extended recovery time and prohibited players from returning to full athletic activity. The statistically significant difference between the two groups was not noted on the first and third day. However from data recorded on the third day, the lower pain level is clearly noticeable in the study group. The lack of a statistically significant difference on days 1 and 3 may be the product of a small sample size in both groups. Therefore, more studies with larger samples are required.

The study results confirm Jendrysek's claim (12) that kinesiotaping contributes to pain reduction processes. He posited that this was through the reduced pressure on the skin mechanoreceptors and through the improvement of the subcutaneous blood and lymph flow. In turn, these effects influence the decrease of hypertonic muscles and the activation of the self-healing pro-

cess, and consequently quicker return to a full physical activity of a player.

The effectiveness of kinesiotaping in pain reduction is also confirmed by research conducted by Merino, Marban, et al. (13) which concentrated their research on the localized calf pain in triathletes following the triathlon races. The tape was applied on the gastrocnemius muscle. Not a single athlete reported pain originating in this muscle. The pain sensation occurred however in areas not treated with the tape.

More corroborating evidence has been provided by Burke (14), who treated seven bicyclists with the inflammation of the patellar tendon and seven with the inflammation of the Achilles tendon. The pain reduction was noted immediately following the tape application.

Gonzalez-Iglesias, et al. (15) confirmed the positive impact of kinesiotaping on the pain reduction in whiplash injuries. The effectiveness of the tape was assessed immediately following the tape application and 24 hours later. The significant pain reduction was reported in both cases.

While analyzing the impact of the kinesiotaping on the improvement of proprioception, the statistical difference between the two treatments was not significant. During the one-leg standing test, the athletes' timing increased progressively in both groups. It should be noted that in the study group, there was not a significant difference in timing between days 3 and 7. This may suggests that on day 3, the tape could have made a direct or an indirect impact on the improvement of proprioception (e.g. through pain reduction or increased range of motion, where each factor could have helped the athletes to carry out more intensive proprioception exercises. In the control group the process of improvement of proprioception lasted until day 7). Moreover, in the study group the majority of participants achieved the maximum value on day 3. In control group there was a significant difference between days 3 and 7. In addition, all athletes in study group achieved the maximum time on day 7, whereas in control group some participants were still below the 30 seconds mark on the same day. The lack of significant statistical differences in this regard may be explained by the selection of a tape application methodology. In the study group, the reduction of affected muscles' tension and in cases of bruising, the reduction of swelling was the main focus of the tape application. The method specifically designed to treat proprioception was not used.

These findings are similar to those reported in Halseth et al. (16), where the authors did not find significant impact of kinesiotaping on proprioception during the treatment of the ankle joint. We do not know, however, what kind of kinesiotaping application the author used. Garcia (17) however reported different results. The author provided evidence suggesting that kinesiotaping indeed effects the recovery process of proprioception. The results show significant difference during the one-leg standing test with closed eyes between a lower limb with the tape application and a lower limb without the tape. The improvement in proprioception in football players with the knee joint injury and treated with the tape was also reported by Ming and Yao (18).

The analysis of range of motion between the two groups is not included in this study due to the divergence of contusions in both groups. It was noted however that both approaches (manual therapy of soft tissue and manual therapy plus tape) had a positive effect on the incremental progression of range of motion. On day 7, most subjects in the study group did not experience deficits of muscle length, and the same individuals achieved range of motion within their norms. However, the fact that more players in the study group as opposed to the control group returned to norm may be due to the types of injuries. Therefore, more studies using a common measure to adequately control variability of injuries are required. Many authors, however, confirm the tape's effectiveness in improvement of range of motion: Yoshida and Kahanov (19) – in lower part of the spine, Thelen et al. (20) – in the painless shoulder abduction, Murray (21) – after the anterior cruciate ligament reconstruction. A significant improvement in cervical range of motion when whiplash injuries were treated with the tape was reported by Gonzalez-Iglesias et al. (15).

The analysis did not take into consideration the effect of the kinesiotape on range of motion before and shortly after the tape application, because the tape's effectiveness has been demonstrated by other authors (15-21). The focus of this study was the measurement of tape's effectiveness over a longer period – specifically on days 3 and 7 following the injury.

The results of this study confirm the efficacy of kinesiotaping in treatment of soft tissue injuries in athletes. The use of this method, along with other physiotherapeutic treatment regimes results in faster recovery periods and quicker return to full physical activity. Kinesiotapes are most efficient in post-injury pain reduction (13-15). The appropriate tape application enhances sensory stimulation originated in joints and muscles leading to improved proprioception. The tape's beneficial properties can be successfully used in physiotherapy of ligament injuries (17, 18).

Other research findings also confirm the positive effect of kinesiotaping on the joint range of motion (15, 19-21). The proper tape application diminishes tension in the area of fascia, reduces hypertonia and pain.

The particular advantage of kinesiotaping is its capacity of providing 24-hour therapy and therefore speeding up the healing process.

The results of this study suggest that the application of kinesiotape in the treatment of soft tissue injuries is effective in post-injury pain reduction in athletes. The method facilitates the rehabilitation process and shortens the recovery time allowing players for quicker return to their full athletic activity. The study does not provide sufficient evidence to support the claim of kinesiotaping efficacy in proprioception. This can be explained

by a selection of the application methods in this study. The main objectives while choosing the most appropriate techniques (muscle correction, joint correction and lymphatic correction) concentrated on reduction of hypertonia, decrease of ligament tension, as well as elimination of swelling around hematoma. The stimulation of mechanoreceptors was not one the study's aims where the mechanical, ligament and functional techniques are used. The lack of evidence supporting the claim of efficacy of the tape on the joint range of motion can be explained by the divergence of injuries and small sample size. To obtain such evidence further studies are required.

CONCLUSIONS

1. Kinesiotaping is an effective method in pain reduction in soft tissue injuries.
2. Faster post-injury pain reduction implies earlier return to full athletic activity.
3. The applied kinesiotaping techniques (muscle and lymphatic correction) do not effect improvement of proprioception in injured athletes.
4. Kinesiotaping can be used as a complementary method facilitating the traditional rehabilitation treatment of soft tissue injuries in adolescent athletes.

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